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Overcoming Barriers to Urban Flood Resilience: A Case of Hyderabad, India

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Abstract

Cities are increasingly faced with frequent floods disrupting everyday lives. Adapting to flood risks and conserving eco-sensitive sites are central to social ecological resilience. Rapidly expanding cities are found short of mitigating the adverse environmental impacts. For enhancing flood resilience, it is important to understand the interaction of the key stakeholders and its impact on governance and land use in the cities. Land use change in urban space is constantly influenced by negotiations among various interest groups. The urban governance structures are increasingly dominated by neoliberal approaches of profit maximization. Following a heuristic framework for policy analysis of land use change and governance, the present study assesses the barriers in building flood resilient cities. We apply the framework to Hyderabad city of Telangana, India, which has faced the recurring challenge of flooding. Results demonstrate the lack of urgency in implementing disaster management initiatives and contradictions in existing policies. This study points out the redundancy of elected municipal bodies for taking flood resilience measures, due to increasing proliferation of nondemocratic administrative bodies and underlines the need to bridge the gap through agendas cutting across sectors and institutions.

Keywords: urbanization, flood resilience, policy analysis, disaster management

1. Introduction

Increasingly, cities are faced with various natural hazards. Urban flooding has increased in frequency and caused loss of life and infrastructure all over the world. Rapid urbanization and increased anthropogenic activities have led to haphazard development on eco-sensitive areas. Changing climate scenario has put livelihood of many vulnerable people at risk. Hyderabad has also faced increasing flooding event over the years. While flooding in 2000 was most destructive for the city in recent times, it has also faced the disruptive floods in 2008 and more recently in 2016 and 2017. Urban governance plays a key role in shaping various processes of disaster risk reduction (DRR) and flood resilience. Primarily, flood mitigation measures can be approached as structural and nonstructural measures. Structural measures include flood defense construction, and nonstructural measures include policy changes, flood awareness programs, and so on. Increasingly, the focus has been shifting from structural to nonstructural measures, which have more long-term impact on flood preparedness and mitigation.

For effective nonstructural measures, we need to strengthen our understanding of root causes behind the urban flooding, for which along with technical knowledge of urban growth, we need deeper understanding of urbanization processes and land use changes. Such an endeavor requires deciphering of power relations between various stakeholders. Urban space is laden with constant negotiations and power conflicts. Sociopolitical tensions and socioeconomic conditions of city dwellers are reflected in socionatural changes in land use. Urban environmental change is the result of deliberate efforts of appropriation of resources by the dominant vested interests, which maintain status quo through fragmented role of institutions and agencies [1]. Hence, governance of socioecological changes cannot be looked in silos but occurs in the highly politicized urban space [2].

‘The prevalent flood governance strategies rely on hybrid forms of neoliberal governance, where technological risk prevention is linked to programs that promote social resilience and cultural adaptation’ [3]. Neoliberalism has a powerful influence on current urban governance and development by defining policy formulations, limiting democratic participation, and managing dissent and counter narratives by proclaiming new futuristic visions of the city [4]. Neoliberalism anchored in supralocal forces of capital accumulation, and there collaborations with state power have managed to engulf cities in market-driven governance regimes.

The neoliberal ideology gives primacy to market forces and motivation to maximize material benefits over the government’s role as a responsible representative of people [5]. The emerging neoliberal self is driven by individualism and consumerism, which comes in conflict with sustainable development [6]. In Indian cities, neoliberal policies had most debilitating effects on economically weaker sections such as forced eviction or displacement of slum dwellers for urban mega projects [7]. The supralocal forces and parastatal agencies behind such mega projects interact with native sociopolitical narratives to produce a complex urban space. Scholars have investigated urban flooding to reveal contradictory nature of neoliberal urban policies such as (see [8]) the study on storm drainage network in Bangalore to bring the socionature intricacies of flow and fixity of water and storm drains, respectively. Another study on Surat highlighted the overlapping nature of risks in the city [9].

In context of Hyderabad, there are few studies examining urban flooding. Most studies are technical in nature, which use GIS tools for presenting land use change, vulnerability, and flood prone areas. Theoretical studies analyzing the policy changes and its implementation are scarce. Among policy-oriented studies, some have explored the increasing pollution and vanishing of the water bodies. And others have looked at urbanization processes, broad governance issues at the municipal level, and financing of various government projects in the city. While investigating the urban flooding, the present study is also an attempt to integrate the relevant literature in informing urban flood resilience in Hyderabad.

Following above theoretical framework, the next section elaborates the methodology, Section 3 describes the way urban development activities have contributed to flooding. Section 4 presents an analysis of policy, implementation, and existing barriers. Section 5 discusses the ways to overcome the barriers to urban flood resilience. And final section gives the concluding remarks.

2. Methodology

Unplanned development and growth of the city pose not only the ecological risk but also risks the sustainability of city itself. Policy framing and implementation give a more organized platform for a restrictive and planned process for city

growth. It plays an important role in the regulation of land use change, building resilience and mitigation of hazards as urban flooding. Environmental acts, building regulations, and realizing the ground implementation of policy documents have a key role in flood management in the city. Hence, in cities frequently faced with hazards, it becomes essential to critical analyze both the policy framing and its implementation. Therefore, in the present study, various official documents such as government orders, municipal laws, environmental policies, court orders, civil society engagement, and existing research literature are analyzed to understand the present flood vulnerability in Hyderabad (**Figure 1**). Also, the focus has been to look at policy gaps in two ways. One is the gap in terms of conception of the policy whereby policy documents itself fail to recognize the complexity of the challenges of environmental hazard faced by the city. And second is the gap in policy conception and implementation whereby policy documents may be ideal to follow, but implementation has lag behind in releasing the vision of such policies.

First, digital elevation model (DEM) of the area under Greater Hyderabad Municipal Corporation (GHMC) was prepared to have better understanding of the topography of the study area. DEM represents the land surface and helps to visualize the terrain of an area. DEM for Hyderabad city was obtained from Bhuvan Cartosat. It was clipped using mask layer of shape file of the city and processed in QGIS. Second, to analyze the policy and implementation, this study employs heuristic framework of reflexive governance. This framework analyzes in terms

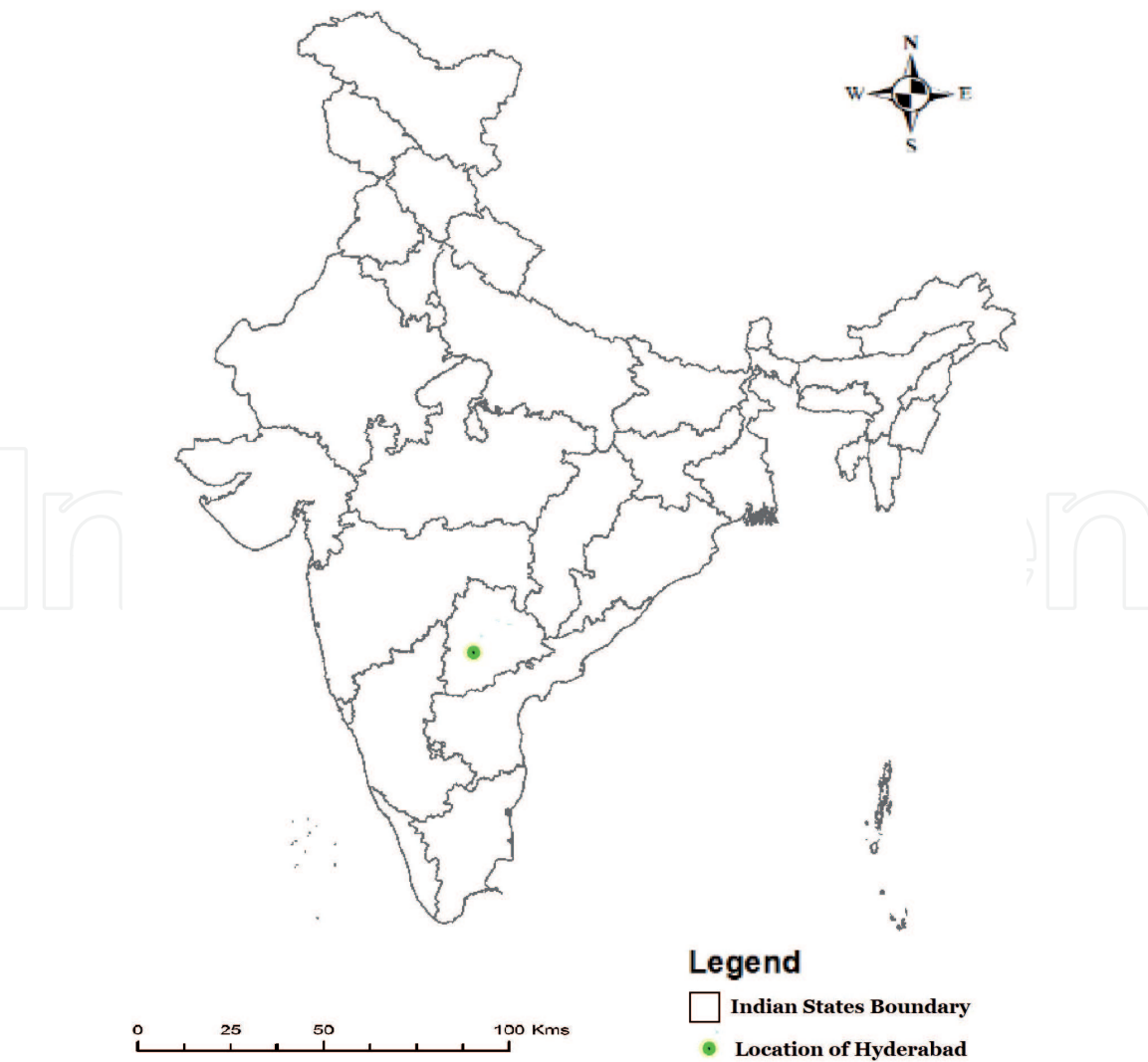


Figure 1.
Location of study area.

of policy, polity, and politics with three levels of governance at macro, meso, and micro. In adapting the framework for the current study, the policy aspect highlights the problem at hand. Polity aspects elaborate on formal instruments and key institutions such as master plans, disaster management acts, and so on. Finally, the political aspects focus on barriers in improved governance and interaction among various stakeholders.

Heuristic framework can be applied to understand the interaction among the key interest groups and its impact on land use change and flood management [1]. Framework is useful in discerning blind spots and prevailing narratives to address shortcomings in governance. It draws attention to the power relations among various actors influencing the urban change to fulfill particular interests [10]. The main documents that have referred in the present study at macro level are disaster management act 2005, disaster management policy 2016, role of national disaster management authority (NDMA), and its plans/guidelines. At meso level, role of state disaster management authority (SDMA), Telangana climate change plan, state level urban policies, and urban mega projects have been analyzed. Lastly, at micro level, the main focus was on the master plans, building by laws, municipal governance, and their impact on the city sustainability and flood vulnerability.

3. Results and discussion

3.1 Impact of anthropogenic activities on urban floods

Role of anthropogenic activities that have been responsible for increased flood vulnerability in Hyderabad is discussed in this section. An attempt was made to bring the entire study area into a DEM for better understanding and evaluation (**Figure 2**). Thus, from the terrain elevation model, it can be observed that the maximum elevation is in the western part, whereas the minimum elevation is seen towards south east of the city. The low lying areas particularly surrounding water bodies as lakes and rivers are not favorable for habitation. And any extension of built up area around these sites must be with some precautionary measures and at best avoided. But most of such areas have already been covered by dense population. As per the census, population of Hyderabad increased rapidly from 3.05 million in 1991 to 3.64 million in 2001. And after creation of GHMC in 2007, it reached to 6.81 million on 2011. Most vulnerable to urban flooding is the population with minimum socioeconomic resources to cope with disasters. As per the last census 2011, there were 2.29 million people residing in slum and squatter settlements in Hyderabad. As per GHMC's own estimation, there are 13,509 families directly vulnerable to flooding in the city.

The maximum mean monthly rainfall in last decade has been recorded 544 mm in August 2000. The lowest rainfall is mostly in the months from December to March. Highest average rainfall for 100 years (1908–2008) in Hyderabad is observed in the month of July (192 mm) followed closely by August (182 mm) and September (180 mm), that is, during southwest monsoon. In August 2000, Hyderabad recorded a rainfall of 240 mm in a day, consequent flooding affected 35,693 homes and 26 people lost their lives along with estimated property loss of Rs. 13.5 million. In August 2008, 237 mm rainfall in 36 hours resulted in property loss of Rs. 4.9 million [11]. But even small rainfall presents the challenges in the city such as with just 50–60 mm rainfall in July 2005, transport came to standstill, and there were deaths from being swept into the manholes. In recent flooding in 2016 and 2017, there were many reports of death due to collapse of walls, roofs,

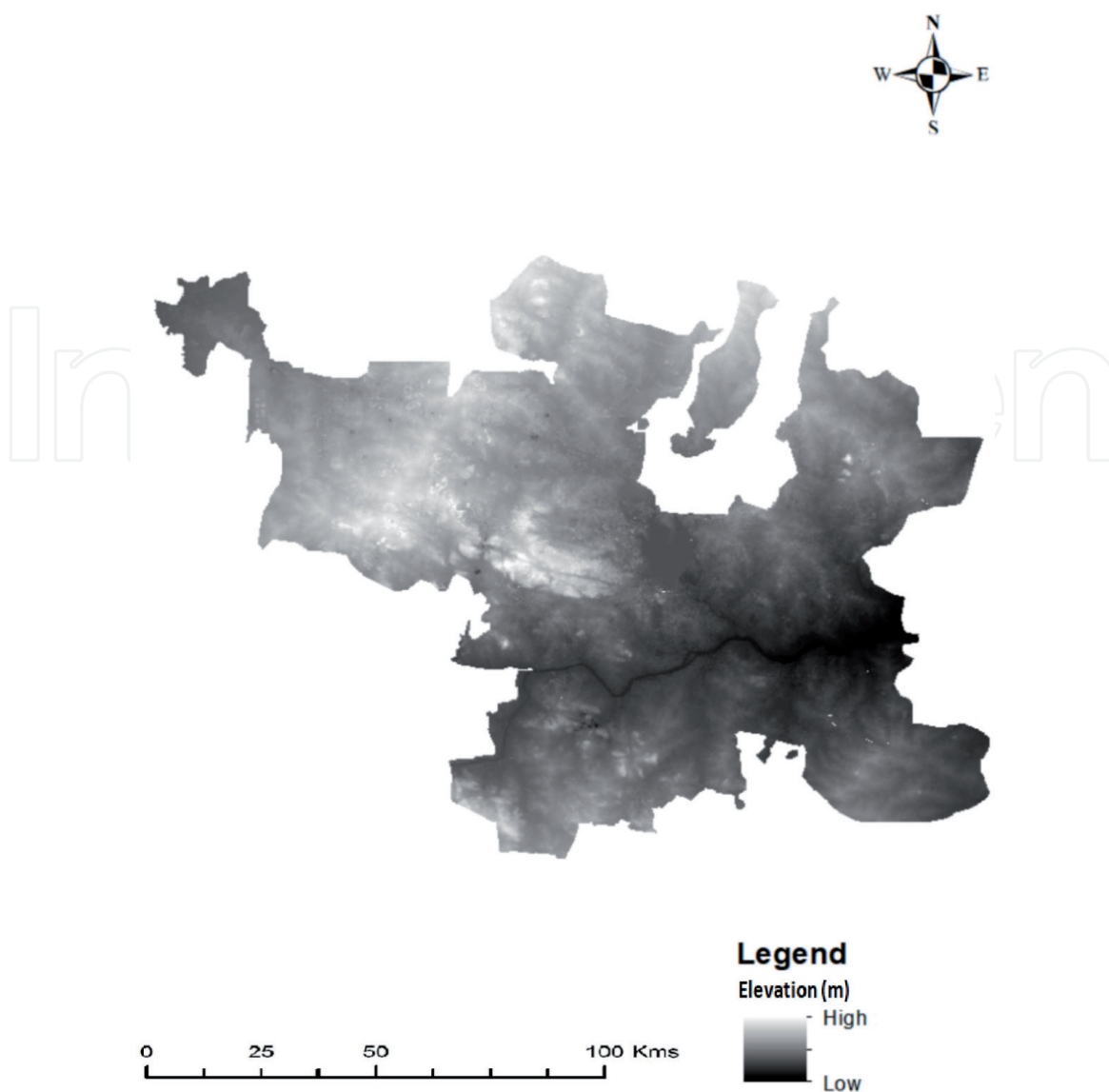


Figure 2.
 Digital elevation model of Hyderabad.

and buildings after rainfall. In some localities, National Disaster Response Force (NDRF) has to be called in for rescue and relief operations.

Concretization cover has increased rapidly over the year's throughput the city. Total build up was 17,092 ha in 1964, which increased to 26,312 ha in 1974 and 45,550 ha in 1990. Area under the river/streams changed from 762 ha in 1964 to 512 ha in 1974 and further to 312 ha in 1990 [12]. It is the low-density area that has continuously contributed to high-density urban area growth in the city. Total urban built up area of low- and high-density area has grown by 43,607 ha between 1989 and 2011 [13]. Total built up area in 2015 for Hyderabad urban agglomeration increased to 86,535 ha.

Water bodies have been worst affected by such rapid haphazard urbanization. Construction activities on lake and river bed have pushed more people toward high vulnerability to floods. Water bodies in the area are reduced from 2.28 to 1.64% from 2001 to 2016 [14]. Area under water bodies reduced from 5949.28 ha in 2001 to 4764.73 ha in 2015, that is, area of 84.61 ha/year of water bodies has vanished [15]. The expansion in peri-urban has also been at the cost of vanishing water bodies. Urban sprawl has consumed water bodies and open lands to accommodate housing and other economic activities. Even the floodwaters carrying channels

connecting one water body to the other have been encroached by private, government agencies, and their coalitions [16].

Pollution and waste disposal have further aggravated the flood vulnerability by clogging the drainage system and degrading the water bodies with toxic industrial chemical waste. The black-colored sewage of untreated toxic effluents from many industries is discharged into Hussain Sagar Lake through Kukatpally nala [17]. Further during Ganesh festival, many idols made of plaster of Paris (PoP), iron, and other chemicals are immersed in Hussain Sagar Lake. After dissolving, these idols not only alter the water quality but also accumulate in the lake bed causing serious damage to the lake [15]. Solid waste disposal is another concern as unsorted waste ends up in the water bodies, which clogs the drainage system and results in flooding of nearby areas. The uncontrolled disposal of solid waste will also worsen the condition with increasing pace of urbanization. The projected per capita solid waste generation by 2021 in GHMC is likely to be 803 g/cap/day [18].

Peri-urban expansion in the city has even affected the agriculture land. Open cultivated lands act as sponge for excess water during heavy rainfall, but with increasing concretization, agriculture land use has reduced in Hyderabad over the years. In the city's periphery, in Medak, of 66,055 ha that has been put to nonagricultural use, nearly half have been consumed by the real estate [19]. The Rangareddy area has witnessed such conversion even at more rapid pace. Development projects such as SEZs, outer ring road (ORR), and IT parks have come at the cost of decreasing open and farm land.

Forest areas are essential for maintaining environmental sustainability in the city and help to absorb/slow down excessive runoff water. According to EPTRI [15] report, area under scrub and forest land has decreased from 8189.51 ha in 2003 to 8177.75 ha in 2014. Area under parks and recreational playground has increased from 21.68 ha in 2003 to 50.92 ha in 2014, and urban vegetation has increased from 11.31 ha in 2003 to 27.73 ha in 2014. This can be misleading as many parks and urban vegetation have come up on the lake beds to attract tourism and recreational activities. As often lakes are encroached, dried up, and converted into parks such as Chacha Nehru Park came up on site of Masab Tank, similar is the case for Yousufguda cheruvu.

Hyderabad has even been affected by legal and illegal mining in the city, which has degraded land. Other than sand mining, there is active mining of feldspar, limestone, and granite in the city and its periphery. Most of the laterite and granite mines are in the Rangareddy district. High Court issued guidelines under which the mines were not allowed to function inside the ORR, and court observed that such mining in the city is threat to residential colonies and environment. Deccan chronicle has reported frequent mining explosions in Manikonda, Puppalaguda, and Vattinagulapally localities in complete disregard of the norms [20]. Such land use pattern will only add to the woes of flood vulnerability in the city.

The multiple processes of land use for economic growth have severely degraded and concretized the land in the city. This has resulted in increased flow of water even after moderate amount of rainfall. Disappearance of water bodies has reduced the aquifers and capacity of land to act as absorbent for rain water. In the next section, the policies and acts have been analyzed to understand the process that leads to such dismal conditions in the city.

3.2 Policy gaps and flood risks

Following the heuristic framework of reflexive governance, analysis is organized in terms of policy, polity, and politics with three levels of governance at macro, meso, and micro (**Table 1**).

Levels	Macro			Meso			Micro		
Politics (Focus on barriers to improved governance)	Lack of mainstreaming of DRR and spirit of decentralization.	Poor awareness, risk mapping and clarity on disaster mitigation fund	No mandatory power to NDMA and reliance on ad hoc generation of data.	Non-engagement of SDMA in developmental decisions.	Absence of focus on flood proofing, mitigation and evacuation measures.	Weak regulation of land use and provision of basic amenities.	Administrative vacuum & Influence of real state aspirations.	Parastatal agencies & Supralaocal forces	Incapacity of storm drainage network and absence of efforts for green growth.
Polity (Focus on formal instruments and institutions)	Article 51 A (g), 74th amendment, Sendai Framework	Disaster Management Act 2005, National Disaster Management Policy 2016.	NDMA Plans and Guidelines	SDMA & Disaster Management Cell.	State Disaster Management Plan & State Action Plan For Climate Change	Urban Policy & Urban Mega Projects.	Municipal Corporation & Governance	Building By laws, Municipal Finances & AP Vision 2020	Master Plans & Kirloskar Report
Policy (Focus on problems)	Incoordination and global structural factors.	Fragmentary implementation of disaster management act, policies and financing of disaster mitigation efforts.	Dispersed responsibilities and non-implementation of NDMA guidelines.	Amalgamation of disaster management with other departments.	No comprehensive plans for integrated flood management	Exploitative land use and water management practices	Low level of public engagement and focus on environmental aspects in the city	Focus on short term economic gains	Increased runoff water, decreasing green cover and open spaces.

Table 1.
Policy analysis framework.

Article 51A (g) of the Indian constitution states that “it shall be the duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures.” But over the years, these natural endowments have been degraded, at much accelerated rate in the cities. For realizing the spirit of Article 51A (g) at grass root level, it was essential to empower the local bodies. Seventy-fourth amendment provided for the decentralization of power at the municipal level, which has remained an unrealized dream. Hyogo and Sendai frameworks also stress on national and local level mobilization for disaster risk management. But even these international frameworks not consider how global structural factors, which are out of bounds of local controls, influence the status of disaster risks.

NDMA is topmost organization for disaster management in India. It has fallen short of successfully coordinating with state and district authorities. Rather many times, other government bodies are found to be filling the shoes. This is because of dispersed responsibilities for different disaster and no mandatory power to enforce its guidelines. NDMA guidelines provide for city disaster management committee, formation of community-based disaster management plans, and urban citizens’ forum for disaster risk reduction in the cities [21]. But none of such active bodies or plans can be found in Telangana with national and state level coordination.

NDMA is more occupied with rescue, relief, and rehabilitation. There is no institutionally centered mechanism for collecting the disaster risk data and archiving the disaster lived experiences of population, rather agencies mostly function on ad-hoc generation of data [22]. Another area of concern is the identification of victims, which becomes more challenging in case of mass fatalities in disaster, and NDMA plans/guidelines do not address victim identification process [23]. In terms of financing DRR, there is still no clarity on disaster mitigation fund even though supreme court has also urged for its creation as per Section 47 of Disaster Management Act 2005 [24]. Rather, its absence is justified by the presence of many existing social sector schemes [25].

Further, more than decade after disaster management act 2005, center has failed to convince and convey the urgency for the need of independent disaster management bodies and their coordination with various departments across sectors. Many states still do not have full-fledged disaster management plan to imbibe the Sendai Framework for Disaster Risk Reduction 2015–2030. At national level, recently National Disaster Management Policy 2016 was prepared.

At meso level, there are serious gaps in policy framing and implementation. Disaster Management Act 2005 under Section 14 asserts for the formation of SDMAs for effective disaster management. Telangana has formed State Disaster Management Response and Fire Services. But it is more concerned with fire safety, even training and evacuation procedures are also limited to fire incidents. There are no concrete guidelines, procedures, and mock drills for flood evacuation. As seen in floods during 2016, it heavily relies on the response of NDRF for evacuation and rescue operations. In Section 22, mandates for drawing state disaster management plan as per national plan, and under Section 28, SDMA is to ensure a disaster management plan for all departments. The Telangana State Action Plan for Climate Change only briefly mentions the floods and does not even address urban flooding as the particular challenge facing the cities in the state. In City of Hyderabad, only administrative structure to be found is the disaster management cell under GHMC. Absence of proper administrative structures and comprehensive plans results in conflict and poor accountability in disaster management.

Another concern at meso level is urban policy, which directly influences the land use change in the city. Socioeconomically, vulnerable populations inhabiting the low lying river and lake bed areas are most affected during flooding in the city.

Specifically, in Hyderabad, there is continuous inhabitation along the Musi River, which at many places such as Chaderghat, Shankar Nagar Colony, and so on get inundated, and overflowing sewage/wastewater frequently enters into the houses. Poor provisions of basic amenities as proper closed drainage for wastewater further worsen the situation. Not surprisingly, drinking water many times may get mixed with wastewater. The weak regulation of land use provision in the urban policy is the primary reason for diversion of eco-sensitive areas for fulfilling the real-estate aspirations. Hence, a state level urban policy sensitive toward the needs of vulnerable population will inspire municipal bodies for proactive flood resilient outlook for the city.

Urban mega projects such as outer ring road and Hyderabad Metro project have also compromised urban flood resilience. Metro project has been very contentious with questions on land acquisition in eco-sensitive sites in the city, lack of public engagement, and sidelining of municipal body [26]. In case of outer ring road (ORR), supposedly a road-cum-area development project was in violation of Government Order (GO) (see [27]), and nearly half of the land required was under agriculture. The erstwhile Government of Andhra Pradesh has been directly involved in encroachments of lakes by omitting full tank level (FTL) markings and particularly in case of Hussain Sagar Lake by building the memorial parks [28]. Such diversion of large agriculture tracts, vegetation, lake/river beds, and their rapid concretization has been one of the primary reasons behind the increased surface runoff resulting in flooding. State government initiatives for riverfront development as Nandanavanam project in 1997 and Save Musi Campaign in 2005 were ill conceived, which led to eviction and public interest litigations. Latest attempt of grander project was announced in 2017, which was put on hold, while Musi River continues to be polluted, encroached, and prone to flooding [29].

Analysis at micro city level in Hyderabad further reveals the existing policy gaps; particularly, it is helpful in discerning gaps in implementation of policy at ground level. Municipal planning process can be traced to the formation of Hyderabad Urban Development Authority (HUDA) in 1975. It is in the wake of liberalization and decentralization in the 1990s that a new phase of urban process followed, which completely changed the city. Urban flooding is geographically local phenomenon, and municipal bodies are at forefront in facing the immediate challenges of urban flooding. Even then, since the 1990s, Hyderabad municipal governance body has either been sidelined or downgraded as the city has seen long periods of democratic deficits and administrative vacuum [30].

This has coincided with the proliferation of state supported parastatal bodies, which were out of the preview of municipal bodies but had large role to play in the development of city infrastructure. Hyderabad municipal bodies had no involvement whatsoever in their formation or working of these bodies. These parastatal bodies were created for specific purposes to turn Hyderabad into a global city and favorite destination of investments. But this has compromised the city's flood resilience not only in terms of infrastructure but also putting more vulnerable people at risk of flooding. Some of such bodies are Hyderabad Airport Development Authority (HADA), Cyberabad Development Authority (CDA), and many other Industrial Area Local Authorities (IALAs).

HADA acquired land in the catchment area of Himayatsagar Lake, threatening the existence of the water body. Development of Cyberabad and nearby Serilingampally ward saw influx rural migrants sheltering in slums. As per the Census 2011, the ward of Serilingampally has one of poorest provision of basic amenities in Hyderabad. The above concretization of city has been because of flouting of building bylaws resulting in vanishing agricultural land, vegetation, and water bodies.

This has reduced the capacity of the land to absorb rain water and increased the runoff flow. The whole process of parastatal bodies for the creation of world class enclaves has put greater number of people at risk of urban flooding.

The creation of parastatal bodies has also been the reason for limited financial capacity of Hyderabad Municipal Corporation to take up effective flood management and preparedness. As per provisions for governing IALAs, significant part of building fees and property taxes is kept internally; hence, collected revenue is barely shared with GHMC [31]. Creation of such bodies also surpasses democratic process as the decision-making process does not involve the elected member of municipality. Rather that is the primary reason, such bodies are created to cut through the scrutiny and achieve faster implementation of the plans by the state. This has only undermined the city's flood resilience as in pursuit of global city imaginary, basic urban challenges of provision of efficient drainage and protection of urban commons have been neglected.

Such pursuits of seeing city as engines of growth by creating parastatal bodies and bypassing democratic institutions have its origin in neoliberal supra local forces. The imagination of Chief minister Chandrababu Naidu of transforming Hyderabad as information city was influenced by Malaysia's technological corridors, which in turn are based on silicon valley imaginations. To persuade for investment of funds in Hyderabad, under the aegis of World Bank and IMF, Naidu hired McKinsey for preparing a model development plan that resulted in AP vision 2020, which guided the transformation of the city in the next decades [32]. The effort to project the city as technological hub was successful, and the following concretization left the landscape flood prone with accentuated disparities.

Influence of supra local forces, which are independent of municipal body engagement and bypass democratic institutors, has also seen development of many special economic zones (SEZs). And as mentioned earlier even though the high court had initially prohibited any mining activities inside the ORR, it was exempted for some to supply of raw material for developing SEZs. One can only imagine the two folded damage of quarrying, and increased pace of concretization would have done to city's flood resilience.

Other than above forces, role of GHMC has not been encouraging in city's increased vulnerability to floods. Areas near the drains in several localities such as Malkajgiri, Alwal, and Ashoknagar were completely inundated during floods in 2016 and 2017. There is only 1200 km of storm water drains with carrying capacity of only 2 cm of rain/hour [33]. The Kirloskar report had suggested demolition of many structures and widening of drains, which has been long pending. As in case of other urban agglomeration, major development activities in Hyderabad are guided by Master Plans. Fragmentary nature of process can be seen in master plans for the city. Surpassing the existing institutional structures and master plan for the city, new agencies like CDA were provided with special master plan with separate building rules, land use, and financial instruments [34]. This has only exacerbated the tendency to see the planning area in isolation from its broader socioecological context. Poor implementation and lack of harmonization between the master plans have left it more vulnerable to floods over the years.

The HUDA's 2003 draft master plan proposed to increase area under water bodies to 95.44 sq.km by 2020. But, the area has shrunk by over 10 sq.km, and there were no modalities in plan for reclaiming the lost area [16]. The zoning regulation in the latest Development Plan 2031 (Master Plan) for the Hyderabad Metropolitan Region also has no priorities for the protection of areas such as farm and scrub land, which act as sponge for absorbing rain for the city [35], thus leaving the land vulnerable for real estate aspirations and urban flooding in the coming years.

3.3 Toward urban flood resilience

Resilience requires attention toward transformative attributes and long-term process that help system absorb shocks and stressors. Focus for building resilience to urban flooding can range from strengthening specific resilience at local level to general resilience at national and global levels. For rapidly growing cities, this involves efficient coordination and collaboration at various administrative levels for assisting gradual changes while being attentive of indirect impacts [36].

Resilience strategies are embedded in sociopolitical power structures; hence at international and national policy levels, an impact assessment of global structural factors' influence on local disaster risks is much needed. Accordingly, strengthening and guiding of local bodies by coordination of national and state level bodies are an essential step in giving responsive governance and building resilience to disasters. This may be achieved by giving mandatory power to NDMA to enforce the guidelines. Disaster risk mapping, data collection, and archiving are increasingly central to efficient response, which can be institutionalized in NDMA or with National Institute of Disaster Management (NIDM). NDRF has been shining armor in times of crisis and can mentor State Disaster Response Force (SDRF). For identification of disaster, victim's Interpol's DVI process may be followed [23].

Objectives of 74th amendment can be achieved by actively engaging district disaster management authority (DDMA) through community participation in making local level plans, forums, and committees for disaster management. Engagement with civil society groups is another area where lot may be achieved as in Hyderabad, there are many active organizations such as Hyderabad Greens, Forum for a Better Hyderabad, and so on, which can contribute immensely to resilience building.

National Disaster Management Policy 2016 places lot of emphasis on flood early warning systems and generating awareness through various mechanisms. It advocates for ward level risk mapping and vulnerability assessment and setting up of urban flooding cell for integrated urban flood management at municipal level. In New Brunswick, Canada, the land use controls were even linked with flood risk mapping with different restrictions for high- and low-risk zones [37]. NDMA guidelines on management of urban flood offer many practical and innovative solutions such as rain gardens, detention ponds, and lined channels [38]. Emphasis is much needed for interagency and interstate coordination through NDMA and SDMA. For financing DRR, there is robust institutional mechanism of National and State Disaster Response Funds. There is a need for more targeted financing for mitigation measures, which can be achieved by the creation of disaster mitigation fund and by encouraging micro insurance cover to low-income groups as highlighted in Prime Minister's Ten-Point Agenda on DRR [39].

Telangana State has taken proactive steps by strengthening the disaster response force and deploying the monsoon teams during heavy rainfall. An independent SDMA nodal body along with SDRF involved in integrated plans, evacuations strategies, frequent mock drills, and generating awareness can go long way in streamlining the fragmented nature of disaster planning. Comprehensive state and district disaster plan well aligned with national plan following the vision of Sendai framework will mainstream disaster with development processes for specifically integrating flood mitigation and preparedness at all levels. For early warning, Telangana planning development society (TPDS) has been involved in weather monitoring on real-time basis through automated station and sensors. Central water commission also assists in early warning with its network of river gauge and rainfall stations. Further, Telangana state remote sensing application center actively

involved in modeling, forecasting, and giving assessment reports for decision making. Presently, in environmental clearance/impact assessment, pollution control board and state environmental impact assessment bodies are responsible. A greater involvement of SDMAs in developmental decisions will catalyze streamlining and mainstreaming of disaster preparedness.

Urban policies are not only mere top down instrument for stimulating economic growth but also opportunity for bottom up engagement of residents, municipality, and civil society for steering toward sustainable disaster resilient cities. Hyderabad has many lakes, and their protection following the GO 111 and demarcation of FTL boundaries will be helpful in protecting them. Planning for catchment area for Musi River along with water treatment and segregation of solid waste disposal will not only revive the river but also reduce the runoff water during the heavy rainfall. Implementation of land use and zoning regulations in execution of mega urban projects will be instrumental in protecting eco-sensitive sites and restricting mindless concretization of city. The government of Germany and England adopted the concept of “room for rivers” and “making space for water,” respectively, which makes land use regulation central to flood management. Germany has ensured flood mitigation with more restrictive approach of land use policy based on the return period of 100-year floods [40].

Political decentralization at the municipal level is central to building disaster resilience in the cities. Active engagement of local institution in developmental decisions instead of leaving them in vacuum will give them greater administrative exposure, which has direct impact on land use change and flood resilience in the city. It will also further the much needed public oversight on the supra local forces of urbanization along with fair sharing of revenue with parastatal bodies or subsuming them to strengthen flood preparedness capacity. Provision of basic amenities empowers people to cope with disruption caused by urban flooding. Many wards such as Serilingampally, Rajendra nagar, and Hafeezpet have poor provision of basic amenities as closed drainage and treated drinking water [41]. Weak housing structure and poor basic amenities particularly in old city area have to be addressed through ward level targeted approach.

Building bylaws in the city encourage rain water harvesting, which help in reduction of run off and flood hazards. They also provide for not sanctioning building permits to floodable areas with nonpercolating soils or more than 45 degrees of slopes or for not taking proper measures of drainage [42]. Floor space index is another instrument through which sustainable urban form in the city can be promoted. No building or development activity is allowed in bed of water bodies and FTL of lake, ponds, and so on [43]. Implementation of model building bylaws and provisions of open spaces will assist in sustainable urban development and flood resilience. Regular inspection and impact assessment of industries/constructions for compliance and protection of water bodies as per water and waste management acts/rules will accelerate the flood resilience in the city [44–46].

Sewage and storm water drains have to be delinked to avoid congestion and mixing of runoff water. By taking into consideration, the natural contours of flow, existing drainage pattern and neighborhood catchment area, maintenance of an integrated storm water system are essential for long-term flood resilience in the city. Kirloskar & later Voyants report had already provided recommendations, and its implementation will strengthen the storm drainage. Master plan should focus more on socioenvironmental factors, restoring urban water bodies, vegetation, and creating a network of multifunctional open spaces. Master plan of Auroville adopted the concept of bioregion where part of area is designated for green growth for environmental restoration, regeneration, and biodiversity. Mandi planning area adopted the zone of “no construction” in the land below the high flood level and

“green zone” in a belt of 25 m buffer along the banks of river [47]. A convergence of hierarchy of plans may be developed as regional plan, town plan, and neighborhood plan along with master plan. These measures will essentially require coming out of silos and periodical review of planning processes.

4. Conclusion

There still exists gap between Sendai framework, national, and provincial level disaster management. Particularly highlighting is the seemingly lack of urgency and poor integration with developmental plans. Policy frameworks at state level influence land use decisions and distribution of public services. Weak land use regulations transpire into degrading natural resources and creating multilevel vulnerabilities. At micro-city level, the development activities are framed under broad master plans and subjected to building bylaws. But, flouting of these laws has led to mushrooming of settlements in the low lying flood prone areas. Particularly noticeable is the influence of parastatal bodies and supra local market forces which often bypass regulations and democratic processes. In this scenario, water bodies, forest, agricultural land, and open spaces are being consumed at accelerated rate to produce real estate products. Current policy approaches being clouded by the neoliberal self and technocratic narratives still see disasters management as separate from developmental processes. The resulting poor multi-institutional coordination can only be overcome by empowering key institutions with agenda cutting across sectors and departments both horizontally and vertically. Focus on green growth and flood proofing with engagement of all stakeholders will play a central role in mainstreaming DRR.

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